MMA-445933H-02

4.4 – 5.9 GHz 2W High Efficiency Linear Power Amplifier
December 2012

Features:

- **30 dB Gain**
- **33 dBm P_{-1dB}**
- **OIP3 45 dBm**
- **26.0 dBm Linear Pout @ 2.5% EVM (802.11 64QAM)**
- **Fully Matched Input and Output for Easy Cascade**
- **Internal Bias Tee**
- **Surface Mount Package with RoHS Compliance**
- **MTTF > 100 years @ 85ºC ambient temperature**

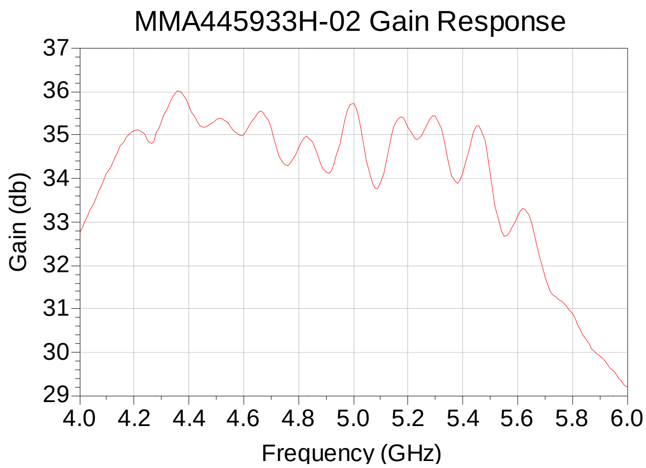
Description:

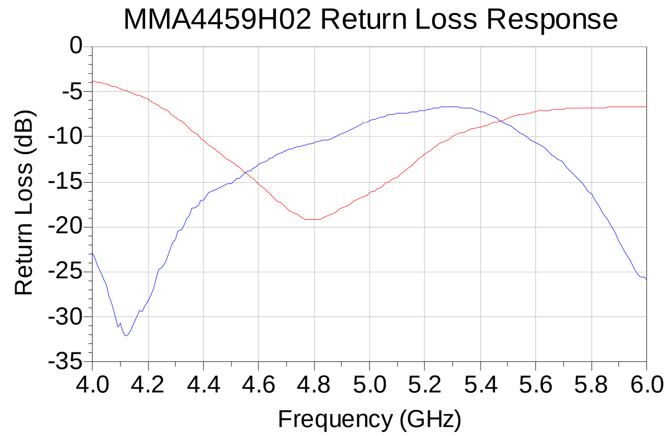
The MMA-445933H-02 is a power amplifier with the State-of-the-Art linear power-added-efficiency between 4.4 GHz and 5.9 GHz frequency band. Based on advanced robust HFET device technology, the linearity of this power amplifier is 26 dBm linear power at 2.0% EVM and achieves an ACPR better than -38 dBc. The modulation test pattern is 802.16x 64QAM. This linear power amplifier also has high gain. Ideal applications include the driver and the output power stage of WiMax and WLAN infrastructures and access points. It also can be used for PTP (Point-To-Point) radio applications for this band.

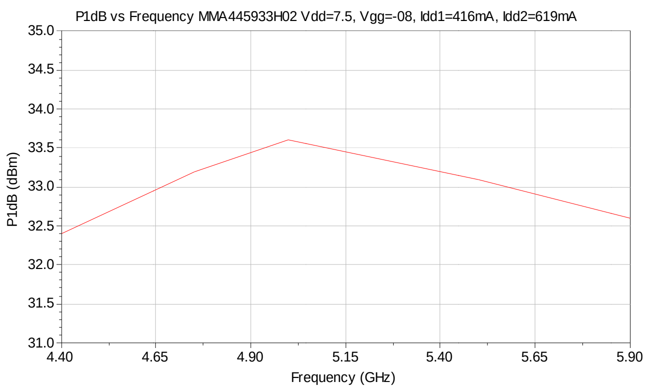
Typical RF Performance: *Vdd1=Vdd2=7.5V,Vg1=-0.8V,Vg2=-0.8,Idq1=410mA,Idq2=620mA Ta=25 ºC, Z0=50 ohm*

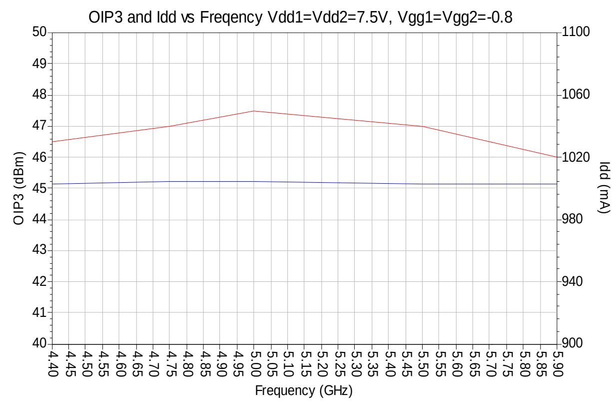
Parameter	Units	Typical Data
Frequency Range	MHz	4400-5900
Gain (Typ / Min)	dB	29 / 33
Gain Flatness (Typ / Max)	+/-dB	2.5 / 4.5
Input Return Loss	dB	10
Output Return Loss	dB	7
Output P1dB	dBm	33
OIP3	dBm	45
Pout @ 2.5% EVM	dBm	26.0
Operating Current Range	mA	1050
Thermal Resistance (Driver Stage)	°C /W	20
Thermal Resistance (Output Stage)	°C /W	16

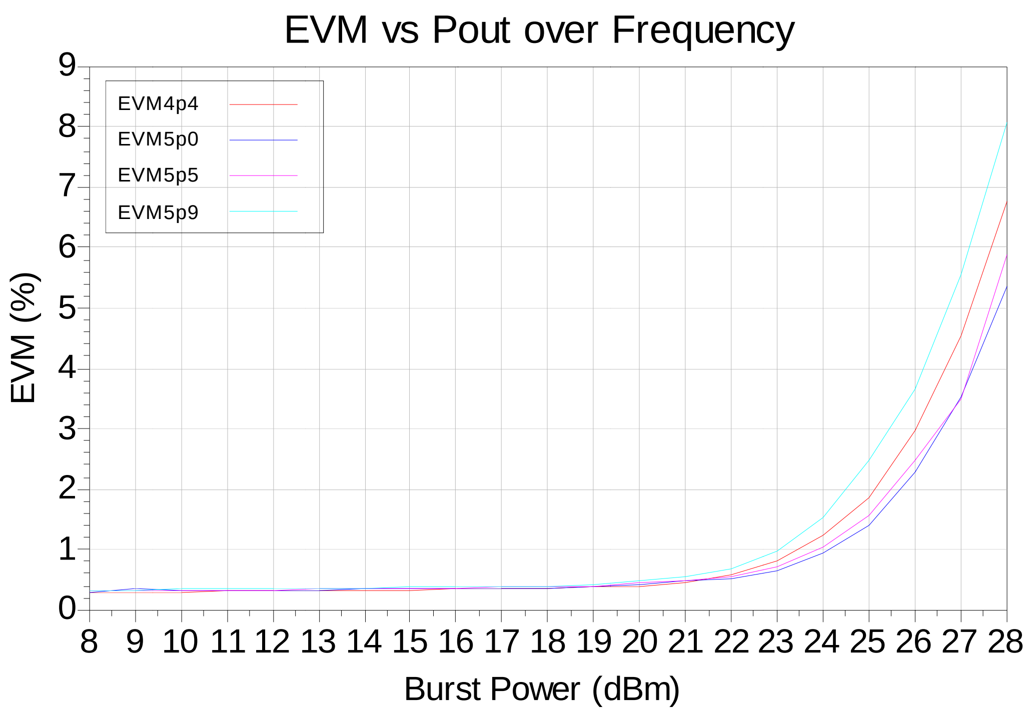
Typical RF Performance: *Vdd1=7.5V,Vdd2=7.5V,Vgs1=-0.8, Vgs2=-0.8V, Idq1=410mA, Idq2=620mA, Z0=50 ohm, Ta=25 ºC*











Maximum Ratings: *(Ta= 25 °C)**

SYMBOL	PARAMETERS	UNITS	ABSOLUTE MAXIMUM
Vdd1	Drain-Source Voltage Driver Stage	V	10
Vdd2	Drain-Source Voltage Output Stage	V	10
Vgs1	Gate-Source Voltage Driver Stage	V	-5
Vgs2	Gate-Source Voltage Output Stage	V	-5
Idq1	Drain Current Driver Stage	mA	500
Idq2	Drain Current Output Stage	mA	750
Ig1 and Ig2	Gate Current	mA	10
Ip	Pinch-Off Current	mA	10
Pdiss	DC Power Dissipation	W	9.0
Pin max	RF Input Power	dBm	+10
Tch	Channel Temperature	ºC	175
Tstg	Storage Temperature	ºC	-55 to 150

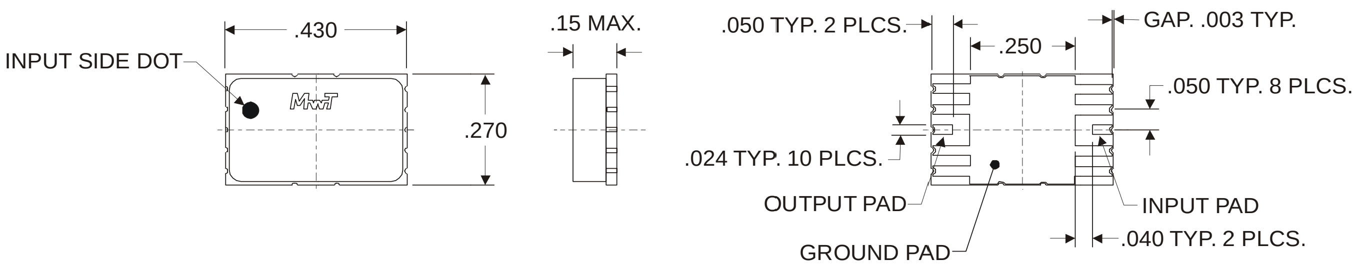
***Operation of this device above any one of these parameters may cause permanent damage.

Typical Scattering Parameters: *Vdd1=Vdd2=7.5V, Vgs1=-0.8, Vgs2=-0.8V, Idq1=416mA, Idq2=620mA, Z0=50 ohm, Ta=25 ºC*

S-paramemeeters Vdd1-Vdd2=7.5, Vgg1=Vgg2=-0.8, Idd1=416mA, Idd2=620mA

freq	magS11	AngS11	magS21	AngS21	magS12	AngS12	magS22	AngS22
4.000 G…	0.645	32.285	43.519	-99.628	0.001	97.671	0.072	22.256
4.100 G…	0.583	19.241	50.770	-128.986	0.001	103.298	0.029	58.433
4.200 G…	0.507	3.416	56.887	-160.542	0.001	104.699	0.039	136.794
4.300 G…	0.405	-13.491	58.229	171.005	0.001	99.811	0.085	155.711
4.400 G…	0.303	-28.862	60.835	137.356	0.001	96.209	0.141	147.883
4.500 G…	0.230	-43.280	58.592	113.084	0.001	99.810	0.175	141.579
4.600 G…	0.174	-60.629	56.340	89.105	0.001	97.310	0.221	137.483
4.700 G…	0.126	-77.940	57.163	60.090	0.001	86.109	0.265	128.530
4.800 G…	0.109	-97.370	54.402	43.453	0.001	94.205	0.291	122.688
4.900 G…	0.127	-120.196	51.026	18.963	0.001	128.273	0.326	119.347
5.000 G…	0.154	-141.350	61.098	-5.354	0.001	117.399	0.386	111.612
5.100 G…	0.189	-153.388	49.493	-24.139	2.849E-4	158.159	0.423	101.495
5.200 G…	0.253	-162.215	57.434	-52.760	0.001	-171.236	0.443	91.180
5.300 G…	0.316	-175.950	59.113	-79.554	0.001	-178.476	0.463	77.581
5.400 G…	0.357	169.576	50.821	-99.637	0.001	163.283	0.437	61.712
5.500 G…	0.399	158.603	50.854	-137.348	0.002	176.446	0.366	48.775
5.600 G…	0.435	147.247	45.402	-151.993	0.002	169.971	0.294	37.350
5.700 G…	0.451	137.700	38.623	177.226	0.002	168.668	0.224	29.044
5.800 G…	0.458	131.897	35.013	157.753	0.002	169.718	0.152	25.486
5.900 G…	0.462	128.232	31.307	137.326	0.002	162.603	0.084	29.234
6.000 G…	0.465	123.778	28.815	115.352	0.003	170.218	0.051	72.184

Mechanical Information: *This Package is RoHS compliant*



Package Outline

Pin Designation (Top View)			
Pin Number	Signal Name	Pin Number	Signal Name
1 Dot Top Left	Vgg1	10	Vgg2
2	GND	9	GND
3	RF In	8	RF Out
4	GND	7	GND
5	Vdd1	6	Vdd2

All dimensions are in inches

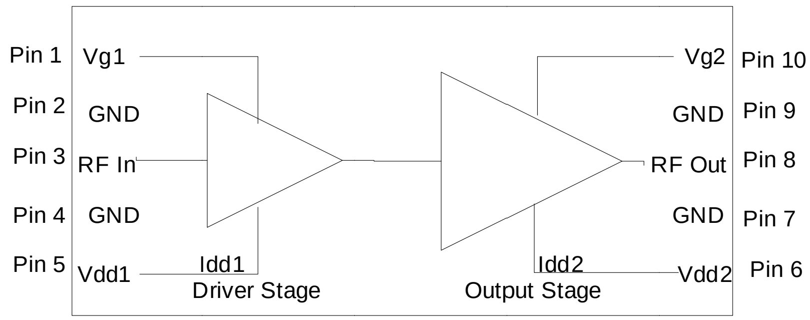


Figure 1 Functional Diagram

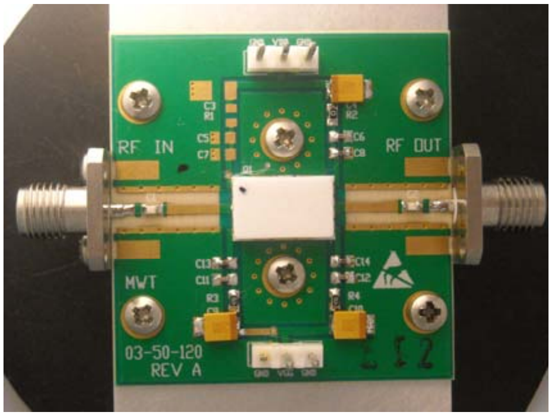


Figure 1 Evaluation board

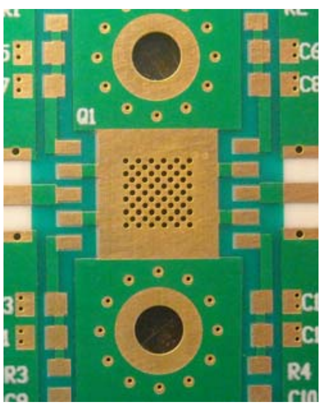


Figure 2 Hole Layout

Application Note

The evaluation board, shown in Figure 1, is fabricated with Rogers's 4003 material, 20 mil thick, 2 oz copper weight and includes four DC input connections and two RF lines. The MMA-445933H-02 shown in the center of board is a 2 watt high gain and high linearity amplifier. The MMA-445933H-02 is a 3 stage amplifier assembly die attach to the modified '02' package which includes four bias entries and two RF connections. The bias tees are built-in to the package. Small value bypassing capacitors are included with assembly. Proper bypassing is still required on the DC lines. The amplifier operates over a temperature range of approximately 85°C.

The PCB requires via holes with a diameter of 20 mils placed uniformly over the center pad for thermal relief and RF ground as shown in Figure 2. The via holes can be back filled with conductive epoxy for best thermal performance. The choice of capacitor bypassing near the amplifier should have a short circuit resonance at the frequency of operation. A small capacitor 3.9pf 0603 from AVX has a series resonance at 5.5 GHz and will make a good choice for the first bypass capacitor.

Followed up with larger value capacitors, 100pf or 1000pf and 2.2uF can be used to maintain voltage stability under peak current conditions. The DC ground via holes should be laid out to minimized inductive returns associated with ground loops. Use of stitch ground via holes can help control the return current and also maintain ground continuity between the top and bottom ground layers. Two mounting holes are used near the PA assembly to secure the board to the chassis; this also minimizes ground current loops and improves thermal conductivity in the absence of sweat soldering the board to the chassis. The internal bias tees inside the PA are quarter-wave stubs at the gate and drain inputs. A 56 ohm resistor is inserted in series to the gate increasing the effective impedance seen from the Vgs power supply and reducing the risk of video oscillations. DC blocks are included with assembly; two zero ohm resistors are used at the input and output 50 ohms traces. The MMA-445933H-02 has a noise figure less than 9.0 dB. A plot of noise figure versus frequency at Idq is shown in Figure 3. The amplifier behaves like a class 'A' amplifier. At small signal levels the amplifier operates at Idq. A plot of P1dB versus frequency shown in Figure 4 is plotted from 4.4 to 5.9 GHz. The drain current Idd1 and Idd2 increases over a range of 1050 mA to 1100 mA from Idq = 1020 mA. This bias condition for this amplifier is class A. The gain versus temperature has a negative slope of -0.07 dB/℃. Other class operations can be set by adjusting the gate control voltage(s). Such operations as class B is doable by backing off the PA stage controlled by Vgg2 control voltage. The maximum input drive level is 17 dBm.

The two tone linearity shown in Figure 4 is swept across a power range from 15 to 25 dBm per tone at the output of the amplifier from 4.4 to 4.9 GHz. At 22 dBm per tone the IMD3 is 50 dBc and OIP3 is 47 dBm. The Burst power shown in Figure 5 is measured across the frequency range from 4.4 to 4.9 GHz at error vector magnitudes equal to 2% and 2.5%. The modulation is 802.16x and each frame cycle has a 10 msec duration and runs continuously. Equalization is enabled when measuring EVM performance. The MMA amplifier bias condition is Vdd1=Vdd2=7.5V and the gate voltage is Vgg1=Vgg2=-0.8V for an Idq=1020 mA.

The gain stability over temperature is shown in Figure 6 and 7. The temperature range was taken at 10 C to 85 C deg and varies 3 dB at a fix frequency.

The EVM versus burst power, shown in Figures 8 and 9 is better than 25.5 dBm for an EVM =2% over temperature and is plotted at two spot frequencies points 4.4 GHz and 4.9 GHz from 10C to 85C degrees.

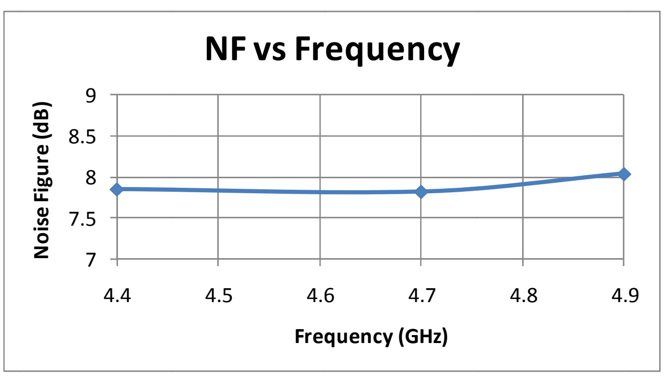


Figure 2 Noise Figure

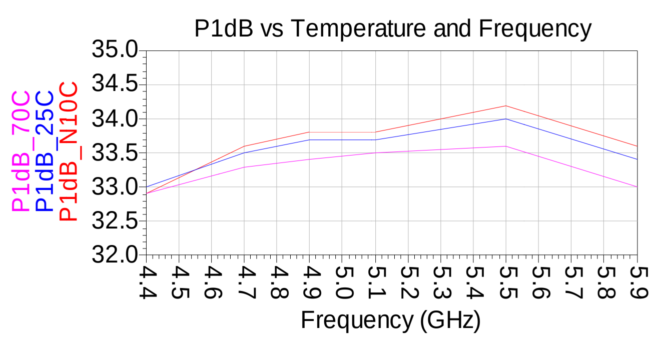


Figure 3 P1dB and Ids

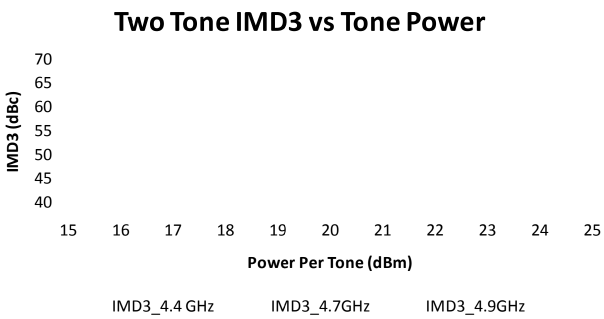


Figure 4 Two Tone

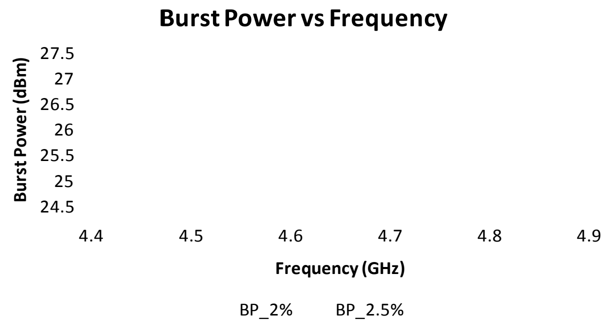


Figure 5 Burst Power

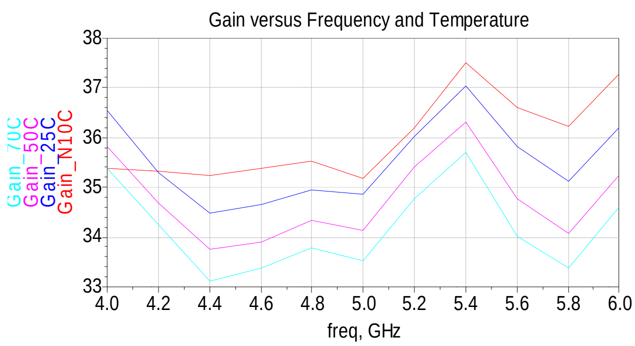


Figure 6 Gain vs Temperature

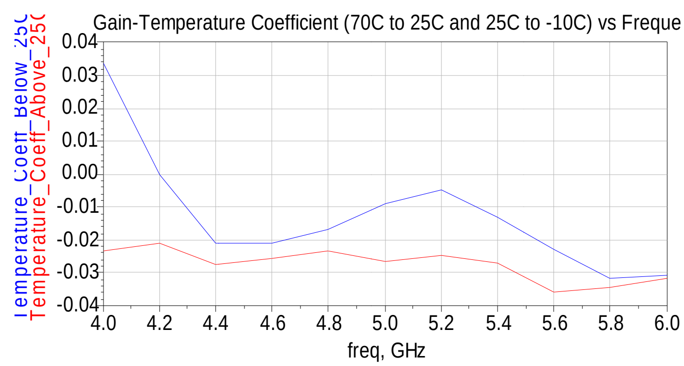


Figure 7 Gain-Temperature Coefficient

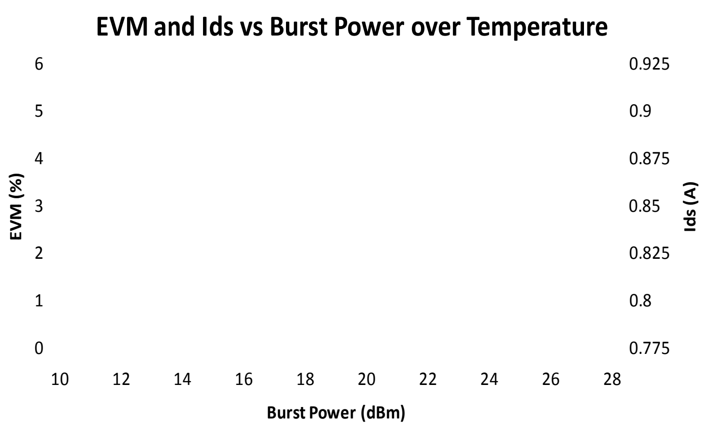


Figure 8 EVM vs Burst Power and Temperature

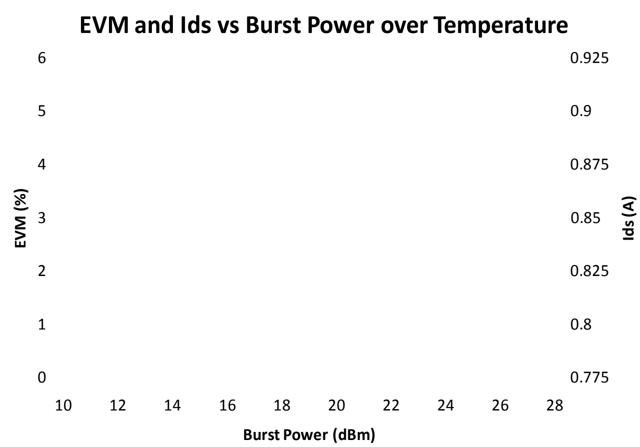


Figure 9 EVM vs Burst Power and Temperature

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